James Moriarity and Virginia Mesenbrink

The Virtual Radio Room (VRR) Project; A Human Systems Integration (HSI) Solution

ABSTRACT

With the advent of the Navy's Revolution in Training, the acquisition community needs to take advantage of the latest technologies available to develop training that is consistent with the Revolution in Training goal of delivering individually tailored, high quality learning to all who serve; anytime, anywhere. That means the training must be compatible with the Integrated Learning Environment (ILE), cost effective, and easy to maintain. The Virtual Radio Room (VRR) is a project that meets this criterion. The VRR is a web-based desktop simulation containing a 3-dimensional virtual environment that replicates an actual radio room where students can perform operator or maintenance procedures. The VRR is being developed using true Commercial Off-The-Shelf (COTS) software and has a modular approach for its architecture to maximize reusability and maintenance.

INTRODUCTION

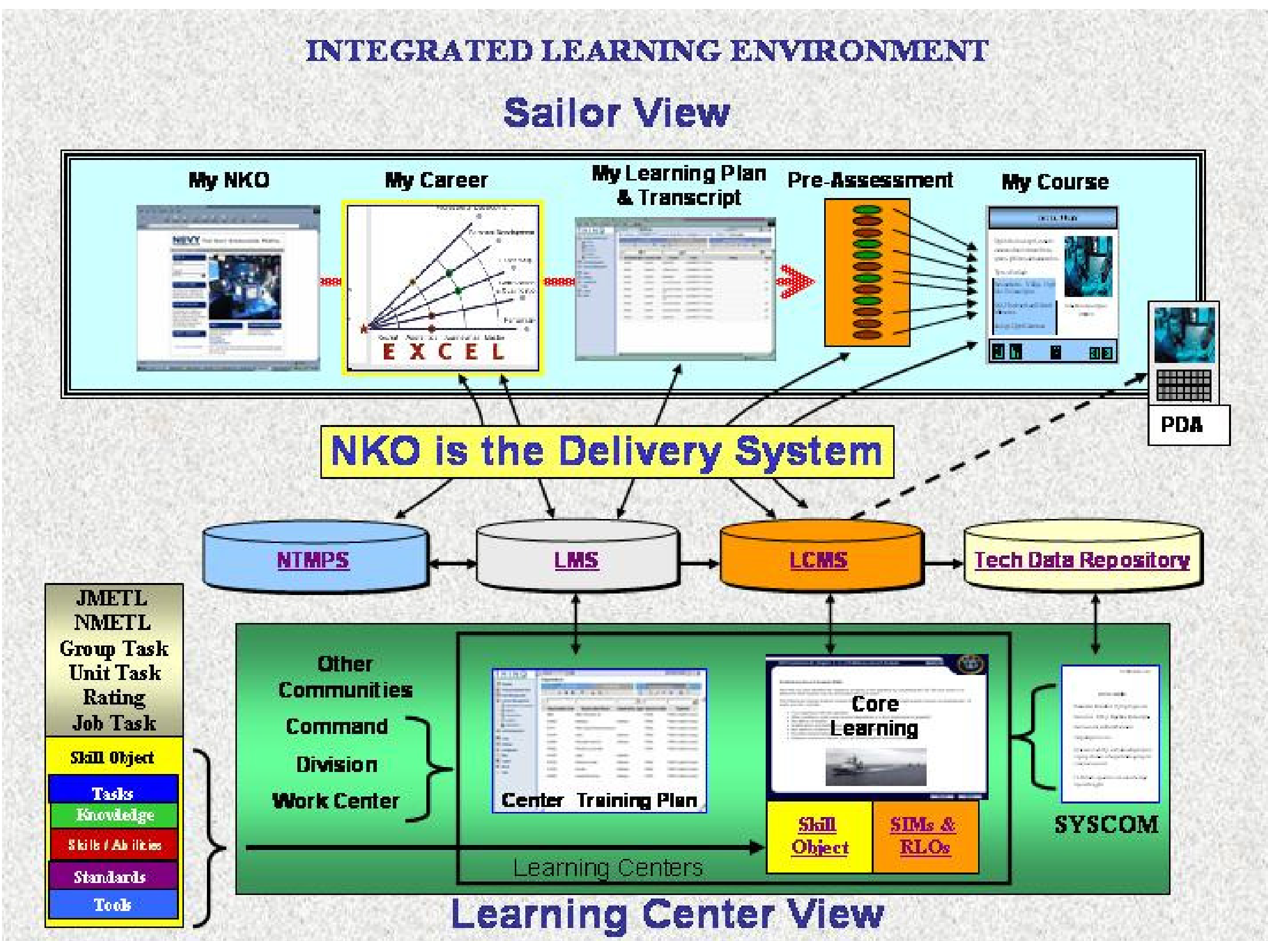
One of the many important aspects of the Human Systems Integration (HSI) process in the design and acquisition of new systems is the need to provide the training necessary to ensure safe and effective operation and maintenance. With the advent of the Department of Defense's Training Transformation and the Navy's Revolution in Training, the technologies employed and delivery methods used for training products have changed significantly. The traditional methods employed are no longer adequate for the needs of the Navy today. The Human Systems Integration (HSI) guidance contained in the current Department of Defense (DoD) instruction, DoD 5000.2, directs program managers to place special emphasis on maximizing the use of new learning techniques and simulation technologies to increase the flexibility, quality, and cost effectiveness of Navy learning tools.

In the past, the training products delivered with new systems varied in format, content, and relied heavily on hardware trainers. The trend now is toward a smaller training infrastructure ashore and making the training available directly to the fleet, regardless of location. Additionally, the focus is now on tailoring the training to a sailor's individual needs based on duty assignments and qualification requirements. The inception of the Integrated Learning Environment (ILE) has enabled this approach and serves as the primary delivery method of the future.

Today, acquisition programs need to develop training products that are compatible with the ILE and rely less on hardware trainers. Simulation is the obvious solution, but not the expensive simulators requiring specialized hardware and software that cannot be pushed to the fleet. Rather, simulation using non-proprietary internet technologies that can be delivered to the fleet via the ILE whenever and wherever it is needed.

INTEGRATED LEARNING ENVIRONMENT (ILE)

The ILE is the mechanism established by the Naval Education and Training Command (NETC) to accomplish the goals of he Navy's Revolution in Training and support the capabilities required for Sea Warrior. The stated ILE vision is, "Improve and support job performance and mission readiness by providing high quality learning and performance support available anytime and anywhere. Provide an environment to analyze, define, develop, document, and implement human performance and learning alternatives, acquire products, and provide lifecycle support per the vision, goals and objectives of the Revolution in Training." The core of the ILE consists of the 5 Vector Model (5VM), Learning Management System (LMS), and Learning Content Management System (LCMS) used to tailor the training to the individual Sailor and makes it accessible through the Navy Knowledge Online (NKO) portal on the Internet, as well provide connectivity to the shore facility's electronic classrooms and interoperability among other systems. Of the key functional participants that are intended to operate in the Navy's ILE are "Acquisition Interests – Those responsible for learning acquisition considerations, including government and private-sector interests having both managerial and technical responsibilities." (Navy ILE, An Introduction, 2006)



The Science of Learning

The CNO's "Revolution in Training" includes the adoption of a new Navy Learning Strategy aimed at improving individual job performance by shifting the focus of training to individual learning needs, applying learning strategies based on the science of learning, and providing individuals with tools that support learning outside of the classroom and in the work environment. Within the Science of Learning body of knowledge, a number of relevant studies and literature indicate that PC simulations can improve learning and transfer to the work environment, especially in cases where practice is required to become proficient at a skill.

Learning from direct experience has long been recognized both for level of performance and for persistence of knowledge over time. This principle underlies situated learning (Brown, Collins, & Duguid, 1989), which emphasizes the role of context in the construction of knowledge. The emphasis for learning, as McLellan (2001) notes, is the actual work setting or highly realistic or "virtual" surrogate of the actual environment. Virtual environments provide simulations that approximate the real environment, including support for exploring the simulated world and objects within. Students can practice skills within the context of real-world tasks, facilitating skills acquisition through "learning by doing" (Dewey, 1939).

Although the studies on cognitive gains have not fully explored combined and individual effects of different components of, applications in, and learning interactions with virtual environments, there is evidence that virtual environments do not decrease learning when compared to other mediated and non-mediated activities (Schroeder & Grawboski, 1995; Salzman et al., 1999). Therefore, even with no difference, simply by virtue of allowing more practice than the laboratory sessions provide, learning and transfer should increase with the Virtual Radio Room. Additional gains are expected through the use of instructional strategies that apply visual, verbal, and audio feedback, and provide a context for understanding the implications of different settings and configurations.

VIRTUAL RADIO ROOM (VRR)

The VRR is a desktop simulation of a surface ship or submarine radio room. The VRR application runs on a windows-based personal computer, either in a standalone mode or as a client-server application. Interactive 3D graphics are used to provide the user with a virtual environment presented on a 2D monitor, where one can practice performing operator or maintenance procedures by interacting with equipment front panels or 3D replicas of components.

Description

The VRR consists of three functional areas; a practice area, assessment area, and an instructional area. The practice area, Figure 1, is a 3D replica of the radio room where the student can navigate around the room using keyboard navigation. The student interacts with the equipment using a mouse. For example, if the student were practicing configuring a communications circuit, he would navigate to the applicable equipments and click on them to bring up front panel emulations to set the appropriate controls. Logic is built into the simulation so students can check their progress at any time or when they have completed the procedure. A student can also access the instructional area if she needs to review the procedure she is working on.

Figure 1. Practice Area

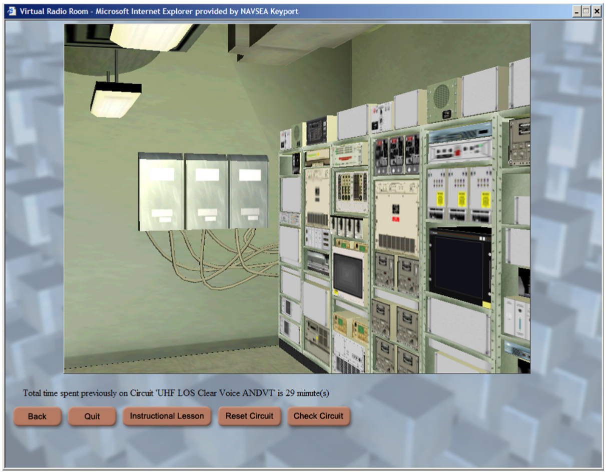
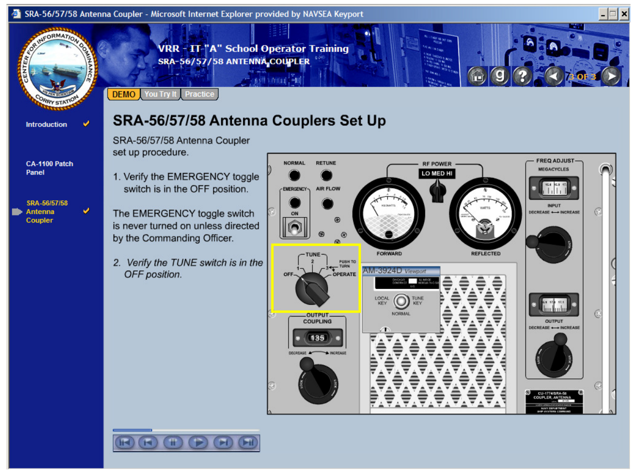


Figure 2. Instructional Leg



The assessment area is used to assess student performance in respect to time and accuracy. The assessment area uses the same environment and interactivity used in the practice area, but the student does not have the ability of check his progress or access the instructional area. Also, logic is built in to allow the instructor to determine what procedures the student will be assessed on.

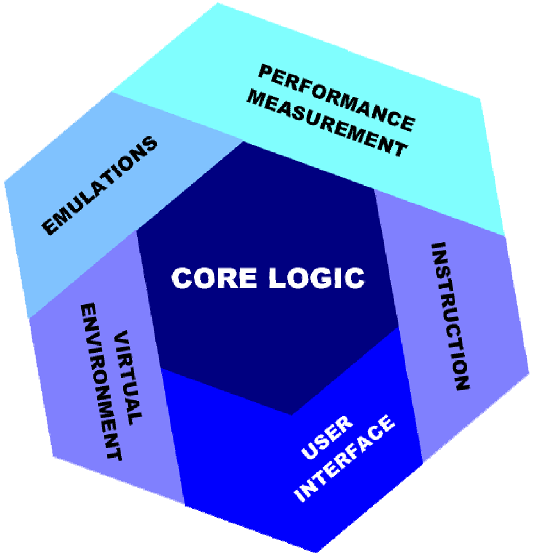
The instructional area, Figure 2, is Interactive Courseware (ICW) segments covering the applicable operator or maintenance procedures.

Architecture

The VRR architecture uses a modular structure consisting of six distinct areas as depicted in Figure 3. The User Interface is the entry/exit point, containing the introduction, navigation, and support tools. It also provides access to the virtual environment and the instructional segments. The Virtual Environment houses the 3D equipment/rack models, contains the environment navigation, and provides interactivity with the front panel emulations. The Instruction area consists of the instructional segments containing detailed instruction on specific procedures. The Emulations area consists of interactive graphical representations of equipment front panels that function the same way as the actual equipment. The front panel settings are retained and shared across the system simulation. The Core Logic consists of the coding that performs the communications function between the functional areas and provides the ability to retain hardware settings, pass measurement data, and launch the instructional segments. Finally, Performance Measurement contains the logic required to measure user performance and provides storage for data relating to hardware settings as they occur and standards for comparison.

The modular structure of the VRR enables maximum reuse of the individual components and makes the content easier to update. Additionally, the VRR architecture is separate from application specific content, allowing reusability of the architecture across the wide variety of potential VRR applications.

Figure 3. VRR Architecture



Tools Being Used
Much effort was expended in determining what tools should be used to develop the VRR. The primary goals were:

- Be able to distribute the product without enduring costly and/or recurring license fees.
- Ensure that it is compatible with the various DoD and Navy requirements, i.e., Sharable Content Object Reference Model (SCORM), NMCI, and ILE.
- Make the product portable so it can be used in standalone or client/server modes.
- Maximize reusability of its components.
- Minimize developer's training costs.
- Take advantage of the latest Internet technologies.
- Create an architecture that can be leveraged for other projects.
- Provide flexibility in selecting developers.

Several modeling, simulation, authoring, and graphics programs were looked at during the design of the architecture to meet the stated goals. There are a lot of very good development tools available on the market. Unfortunately, many of the better products come with what can be very expensive license fees. Communications between products is a problem, as is stability. There are many software products that come and go. And, perhaps the most difficult issue was compatibility with NMCI. This led us to the Macromedia products, now owned by Adobe Systems, Incorporated. Both the Macromedia Flash® player and Director® Shockwave® are listed on the NMCI Gold Disk and are commonly used throughout industry for web development.

We selected Autodesk 3ds Max® for 3D modeling and animation. Adobe's Illustrator® was selected for use in developing 2D graphics. Once the models, animations, and graphics are developed, Flash® is used to create the simulations and Director® is used to create the interactive 3D environment. The Navy's LCMS, OutStart's Evolution® is used to create the ICW. Evolution is used by all of the learning centers and is SCORM compliant. A Microsoft Windows® .dll file and an Access® data base are used to store the required data. Finally, Microsoft Internet Information Services® (IIS) and SQL Server Database Engine® (MSDE) are used for the client/server product. With this selection of tools, we feel that we have met our stated goals.

Current Application

The VRR is a training tool originally envisioned to supplement the existing submarine radio operator training being conducted at the Naval Submarine School in Groton, CT to reduce bottlenecks resulting from the limited availability of Tactical Training Equipment (TTE). Subsequently, the scope has broadened to include surface applications and in some cases substitute for TTE. Currently, the VRR project is being developed for the Naval Personnel Development Command (NPDC) for both surface ship and submarine radio operator and maintenance training. Three of the Navy learning centers are involved in the project; the Submarine Learning Center (SLC), Center for Information Dominance (CID), and Center for Surface Combat Systems. The involvement of the three learning centers has resulted in a good deal of reusability of common components. Additional VRR projects include Information Technology "A" school and Submarine Automated Digital Network System (ADNS) Maintenance (a SPAWAR funded effort).

Implementation Issues

As with most projects, deploying the VRR product has not been without its difficulties. Most of the difficulties encountered have validated the need for the goals we established to select the development tools. We found that the electronic classroom's at the school houses were in various states, some networked, some not, some with external connectivity, some without, some with recent technical refreshes, some without, and in one classroom, the VRR would run on some machines, but not others. We found that NMCI machines functioned differently on the East coast than on the West coast. Also, the simulation specifications for the ILE are not yet published.

Key to any success we have had is collaboration with the learning centers and NPDC. Also, from a technical standpoint, the involvement of the In-Service Engineering Agencies (ISEAs) has been critical.

RETURN ON INVESTMENT (ROI)

There are four basic instances where VRR type products can provide a Return on Investment (ROI). First, as a practice tool for students to improve their performance prior to using actual hardware trainers, thus reducing training time in the trainers. This reduces bottlenecks that many school houses experience due to limited trainer capacity. A second instance would be where it is used in lieu of Tactical Training Equipment (TTE). This is where perhaps the largest ROI would be realized. The third instance is the reusability of the individual components, be it within a product or between products. Lastly, is its use of common, low cost internet development tools and modular architecture, which makes it easy to update.

Another role that has evolved for the VRR is to give more realism to distance learning, or eLearning. There has been, and will be for some time, controversy over the effectiveness of eLearning. There has also been an ongoing debate over the value of simulation versus TTE. While these issues will continue to be debated, certainly it has been established that there are many things that can be done with simulation that cannot be done with TTE (e.g., casualties). As well, there are skills that cannot realistically be accomplished using simulation. The Executive Review of Navy Training (ERNT, August 2001), cites several studies that credit "technology-based instruction with reducing typical costs of instruction by 30-60 percent; associated improvements are either reduction in time to train (20-40 percent) or increases in the amount of skills and knowledge gained by learners (10-30 percent). The Navy experience so far is that savings are more modest, on the order of 10 to 20 percent."

CONCLUSION

The VRR training tool is a solution worth consideration during the acquisition process to satisfy training requirements. There are significant advantages to developing VRR type training products. The same product can be developed for use in the initial training (e.g., installation or dockside) and as a deliverable to the training community that will meet requirements to be Sharable Content Object Reference Module (SCORM) compliant and compatible with the ILE. Where system updates are involved, only the applicable components of the existing VRR product will need to be updated. Additionally, where systems contain common equipment, components of other VRR products can be reused.

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James Moriarity served 20 years in the U.S. Navy in the communications field onboard various surface ships and holds a M.Ed., Curriculum and Instruction from the University of Washington. He worked for Lockheed Martin for ten years providing training support for the TRIDENT submarine program and is currently working for the Naval Undersea Warfare Center Division Keyport as a training specialist developing a variety of training products for use in submarine training and managing the Instructional Technology and Training Branch.

Virginia Mesenbrink is the Project Lead and Instructional Systems Designer for the Navy IT "A" School Virtual Radio Room courseware project, a Navy Science of Learning initiative. With over 19 years experience in software and training systems design, development and support, Ms. Mesenbrink has provided technical and managerial leadership for numerous projects through such roles as Project Lead for Advanced Distributed Learning (ADL) Prototype Projects sponsored by the Joint ADL Co-Laboratory, Systems Engineering Lead for the Aviation Maintenance Training Continuum System (AMTCS) CBT Program, Product Manager for the NUWC Keyport Interactive Multimedia Instruction Development Team, and Manager of the Advanced Distributed Learning Certification Test Center at NUWC Keyport. Ms. Mesenbrink has a B.S. Electrical Engineering from the University of Idaho and a M.Ed., Curriculum and Instruction from the University of Washington.